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Impact of Sociodemographic Factors, Hormone Receptor Status, and Tumor Grade on Ethnic Differences in Tumor Stage and Size for Breast Cancer in US Women

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The importance of sociodemographic factors and tumor biomarkers in explaining ethnic differences in tumor stage and size at diagnosis was investigated in over 106,000 female breast cancer patients reported during 1992–1996 from 11 US population-based cancer registries. Japanese and non-Hispanic White women tended to be diagnosed at an earlier stage, with smaller diameter tumors and with a lower tumor grade than women from seven other ethnic groups. Statistical adjustment for individual- and group-level sociodemographic factors produced 50–80% reductions in the odds ratios for distant (vs. localized) stage and larger (vs. <1 cm) tumor size among Black women and Hispanic women. These factors also helped to account for tumor stage and size variation among most other ethnic groups. Consideration of hormone receptor status and tumor grade had little effect on the ethnic patterns. Although small, elevated odds ratios remained for some groups, our results suggest that sociodemographic factors accounted for many of the observed ethnic differences in breast cancer stage and tumor size at the time of diagnosis. Because most of the sociodemographic variables were aggregate measures, it is possible that residual confounding by socioeconomic position could explain the persistence of slightly elevated odds ratios in some ethnic groups. *Am J Epidemiol* 2002;155:534–45.

breast neoplasms; case-control studies; ethnic groups; neoplasm staging; SEER Program; socioeconomic factors

Observed ethnic variation in the stage at diagnosis for female breast cancer has led to investigations of the potential role of sociodemographic factors and tumor biology (1–5). The three largest studies to evaluate these factors included only White women and Black women, and findings were conflicting with regard to ethnic differences in tumor biomarkers after adjustment for socioeconomic position (1, 2, 5). Other investigators reported no significant ethnic differences in tumor characteristics for Hispanic women (3) and Asian women (4) relative to Whites, but study sizes were too small to draw firm conclusions. Two of the three larger studies were hospital based (2, 5), and one of these accrued study subjects from participants in clinical trials (2), so findings may not be generalizable. This report assesses the importance of sociodemographic factors and tumor biology in explaining ethnic differences in tumor stage and tumor size at diagnosis in a large, population-based series of female patients diagnosed with invasive breast cancer.

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MATERIALS AND METHODS

Study population

The study population included women newly diagnosed with an invasive, primary breast cancer between January 1, 1992, and December 31, 1996, in 11 population-based cancer registries within the Surveillance, Epidemiology, and End Results Program of the National Cancer Institute. These registries cover about 14 percent of the total US population and include the states of Connecticut, Hawaii, Iowa, New Mexico, and Utah, as well as the metropolitan areas of Atlanta, Georgia; Detroit, Michigan; Los Angeles, California; San Francisco-Oakland, California; San Jose-Monterey, California; and Seattle, Washington. Because it was of interest to examine ethnic patterns, the study was limited to diagnoses among the 10 largest population groups in these areas (Hispanic and the following non-Hispanic groups: White, Black, Japanese, Filipino, Chinese, Hawaiian, Korean, Vietnamese, and American Indian). This resulted in a potential study group of 107,096 breast cancer patients. Cases identified from only an autopsy record or death certificate comprised less than 1 percent of the intended study population (n = 599) and were excluded since they lack useful information on tumor characteristics at the time of diagnosis. There were no notable differences between the excluded group and the study group with respect to ethnic category or registry.

Study measures

Specific tumor characteristics at the time of diagnosis (summary stage, size, grade, estrogen receptor and progesterone receptor status) and a limited set of demographic variables (age, ethnicity, sex, marital status, place of birth, county and census tract of residence) were collected on individual study subjects, largely from hospital and pathology laboratory records. Breast tumors that are positive for estrogen receptor or progesterone receptor are correlated with favorable prognostic features, including evidence of tumor cell differentiation and a lower rate of cell proliferation (6–10). Another marker of tumor biology, histologic grade, classifies the degree of cellular differentiation in cancer tissue and is a morphologic indicator of tumor aggressiveness (6). Histologic grade correlates with breast cancer patient survival, with high grade cancers having the lowest survival probabilities (11). This relation persists despite interobserver and intraobserver variation among the pathologists who are assigning the tumor grade (11), and even after the lymph node status of patients is taken into account (12, 13). Therefore, hormone receptor status and tumor grade were included in our study as indicators of tumor biology.

Sociodemographic variables for census tracts in the 1990 decennial census were linked to individual patient records, and each case was assigned the characteristics of the census tract where she resided at the time of her diagnosis (14). These variables were selected a priori on the basis of theoretical relevance (15–17) and empirical evidence of their utility in assessing the impact of socioeconomic position on a variety of health outcomes (16, 18–38). They included the percentage of persons aged ≥25 years who did not have a high school diploma, the percentage of employed persons aged ≥16 years in "working class" jobs (23), the percentage of persons aged ≥16 years who were unemployed, the percentage of households that owned their home, the percentage of households not owning a car, the percentage of persons living below the poverty level, median family income, the percentage of families headed by women with incomes below the poverty level and one or more children at home but with no husband living at home, and an indicator of whether the census tract is entirely urban (14) versus all other.

Statistical analysis

Unconditional logistic regression models were used to estimate the relative importance of ethnicity in explaining the stage of disease and tumor size at the time of diagnosis after adjustment for selected sociodemographic variables and for indicators of tumor biology: tumor grade (well/moderately differentiated, poor/undifferentiated, unknown) and hormone receptor status (estrogen receptor or progesterone receptor positive vs. all other). Patient survival data were used to help in classifying cases that were missing hormone receptor or tumor grade information. Five-year cumulative relative survival was highest, at 89 percent, in the group with either positive estrogen receptor or positive progesterone receptor status and lowest, at 75 percent, in the group that was negative for both estrogen receptor and progesterone receptor. Those with all other combinations of receptor status had a survival rate close to that of the receptor-negative patients (78 percent), so they were grouped with the receptor-negative patients for the logistic regression analysis. Patients for whom tumor grade information was missing had a 5-year cumulative relative survival rate of 84 percent. This is midway between the survival rates for the low grade (94 percent) and high grade (75 percent) patients and similar to the survival rate for patients in grades 1–4 combined (86 percent), suggesting that the unknown tumor grade group was a mixture of high grade and low grade patients.

Other variables included in the regression analysis were age at diagnosis (continuous); Surveillance, Epidemiology, and End Results Program area; marital status at the time of diagnosis (married vs. unmarried or unknown); and interaction terms between ethnic group and the sociodemographic variables. Two sociodemographic variables (percentage unemployed, percentage living below the poverty level) were highly correlated with other sociodemographic variables, so they were excluded from the models. Odds ratios represent the odds that breast cancer patients in each ethnic group had a given category of tumor (later stage or larger diameter) relative to the odds for White women and are presented with 95 percent profile likelihood confidence intervals. Three outcomes were examined: patients diagnosed with 1) distant stage tumors versus localized tumors, 2) regional tumors versus localized tumors, and 3) tumors ≥1.0 cm in diameter versus tumors <1.0 cm.

Because study cases within a census tract may be more similar to each other than to cases in different census tracts with respect to some unmeasured characteristics, standard errors associated with regression coefficients may be underestimated in a traditional logistic regression analysis (39, 40). To account for this correlated data structure, we recalculated standard errors for the odds ratios using the Taylor linearization standard error estimation method in the SUDAAN logistic procedure for clustered data (41, 42). Most of the standard errors estimated by this method were within 1–2 percent of those from the standard logistic regression analysis, and all were within 8 percent, so results are presented from the standard analysis only.

RESULTS

Ninety-nine percent of the 106,497 invasive breast cancer cases had evidence in their medical records of confirmation of their diagnosis by microscopic examination. The confirmation rate did not vary by ethnic group. The predominant histologic type of breast cancer was ductal adenocarcinoma, accounting for 73.4 percent of all cases. Other types included lobular carcinoma (13.2 percent), nonspecific adenocarcinoma (4 percent), mucinous carcinoma (2.5 percent), nonspecific carcinoma (2.2 percent), medullary carcinoma (1.3 percent), and inflammatory carcinoma (1.1 percent). There was limited ethnic variation in histologic type, with White patients tending to have a higher percentage of lobular carcinomas and a slightly lower percentage of ductal adenocarcinomas than most other groups. When patients with ductal adenocarcinoma and those with all other histologic types were analyzed in separate regression models, the patterns of association between the study factors and outcomes were similar. Thus, results are presented for all histologic types combined.

The ethnic patterns of tumor characteristics and sociodemograhic factors are summarized in table 1. Because of the large study size, all ethnic differences in study variables yielded statistically significant chi-squared tests at an alpha level of 0.05. Japanese patients and White patients tended to be diagnosed at an earlier stage, with smaller diameter tumors and with a lower tumor grade than other groups. The increased proportion of low grade tumors among Japanese women and White women persisted after stratification by tumor stage (not shown). Black patients and Hispanic patients were more likely than other groups to be diagnosed with metastatic disease, to have tumors ≥2 cm in diameter, and to have poorly differentiated tumors. American Indian patients and Hawaiian patients also had a larger percentage of distant stage breast cancers. Among patients with information on hormone receptor status, White women, Japanese women, and Hawaiian women had consistently higher percentages that were positive for estrogen receptor or progesterone receptor.

Tumor stage information was unavailable for a small portion (3 percent) of all study cases. The percentage of unstaged cases was slightly higher among Black women and Korean women. Black women also had the highest percentage of tumors of unknown size and unknown grade. Tumor grade was missing for 25 percent of all study patients. Those missing tumor grade were more likely to have distant stage disease (8 percent vs. 5 percent distant among those having tumor grade information) and to be aged ≥80 years at the time of diagnosis (16 percent vs. 11 percent). Information on hormone receptor status was not available for 23 percent of the study population, with Black women, Hispanic women, and Vietnamese women having the highest rates of missing data. Patients who lacked hormone receptor status information were more likely to have distant stage disease (10 percent vs. 4 percent distant among those with information on hormone receptor status) and to be aged ≥80 years at the time of diagnosis (16 percent vs. 11 percent). Forty percent of the patients without information on hormone receptor status were also missing tumor grade versus 21 percent of those with hormone receptor status.

Census tract sociodemographic information was linked to 96.1 percent of the study cases. Cases that were not linked generally had incomplete or nonspecific residence address information that precluded assigning them to a census tract. The age distribution of unlinked cases was similar to the distribution among those with complete information. The Hawaii cancer registry had the largest percentage of unlinked cases (14 percent), and as a result, the percentage of native Hawaiians missing sociodemographic data was higher than that for other ethnic groups.

There were notable ethnic differences in sociodemographic factors. Black women were the least likely group to be married at the time of diagnosis. Black patients, Hispanic patients, Vietnamese patients, and American Indian patients were similar with regard to many of the sociodemographic characteristics of the census tracts where they lived. They were much more likely than other groups to be living in less educated and poorer neighborhoods, as measured by the percentage of residents without a high school diploma and median family income. They also tended to live in areas where residents held "working class" jobs and where a high percentage of families were headed by women with incomes below the poverty level and one or more children at home but with no husband living at home. Korean patients, Vietnamese patients, Black patients, and Hispanic patients lived more frequently in areas with low home ownership. Black patients and American Indian patients lived in areas with low car ownership. Hispanic patients, Filipino patients, Chinese patients, Korean patients, and Vietnamese patients lived in census tracts with higher concentrations of foreign-born persons. Place of birth information for patients, when available, also indicated that the majority of patients in these five ethnic groups were born outside the United States.

Results from multiple logistic regression models, used to assess the importance of study variables in explaining ethnic differences in tumor stage and size at the time of diagnosis, appear in tables 2–4. Patients for whom medical record information was insufficient to assign a tumor stage (3 percent) were excluded from regression analyses of tumor stage, and those lacking information on tumor size (9 percent) were excluded from the tumor size analysis. Unstaged cases were evenly distributed across age groups with the exception of women diagnosed at age ≥90 years (16 percent missing stage). This age group, however, accounted for only 1.6 percent of the study group. Cases missing tumor size were also evenly distributed by age group, with the exception of women aged ≥90 years (18.5 percent lacking tumor size). Additional subjects (3.7 percent) were excluded from regression models when they could not be linked to census tract sociodemographic information. Interaction terms between ethnicity and the group-level sociodemographic variables were not significant, based on a likelihood ratio test, so they were not included in the final models.

Odds ratios for distant stage disease, adjusted for age at diagnosis, were significantly elevated among Black women, Hispanic women, and American Indian women relative to White women (table 2). Odds ratios were significantly reduced for Japanese women and were not significantly different from 1.0 for other groups. The addition of geographic variables (registry where diagnosed, urban/nonurban residence) had little effect on the odds ratios. When sociodemographic factors were incorporated into the model, the excess odds for Hispanic women were reduced by 80 percent (from 1.5 to 1.1), the excess odds for Black women were lowered by 50 percent (from 2.0 to 1.5), and the excess odds for American Indian women were also reduced. Inclusion of tumor grade and hormone receptor status in the final model further reduced the odds ratio for Black women (from 1.5 to 1.3) but did not have a notable effect on the odds ratios for other ethnic groups.

The analysis of regional stage disease versus localized disease (table 3) indicated that ethnic differences are not as great as in the distant versus localized comparison. The odds ratios for Black women and Hispanic women are again elevated relative to those for White women, though at somewhat lower levels than those for distant stage disease. The odds ratio for Japanese women is significantly lower than that for White women, while odds ratios for the other groups are not significantly different from 1.0. The addition of geographic area and sociodemographic factors reduced the odds ratios for Black women, Hispanic women, and American Indian women, but no further reduction occurred after the inclusion of biologic characteristics of the tumors. The lower odds ratio for Japanese women remained unchanged after the addition of each group of potential confounding factors.

The odds ratios for larger tumor size at the time of diagnosis by ethnic group are shown in table 4. In the initial model, odds ratios adjusted for age at diagnosis are significantly high for Black women, Hispanic women, Filipino women, Chinese women, and Korean women relative to those for White women. Sociodemographic factors reduced odds ratios for most ethnic groups, but the addition of tumor grade and hormone receptor status to the model had little effect. The odds ratios for Black women, Hispanic women, Filipino women, and Korean women remained significantly elevated after statistical adjustment for all study factors. The odds ratio for Japanese women was significantly reduced and remained unchanged after each set of study variables was added to the model.

Additional regression models that excluded patients who lacked hormone receptor information were examined, but the odds ratios for ethnic group and sociodemographic variables were unchanged, though the confidence intervals increased slightly. Regression models in which cases that lacked tumor grade information were either combined with those having low grade tumors or excluded from the analysis also yielded results similar to those presented.

DISCUSSION

In this large, population-based study of breast cancer patients, we have noted a variety of ethnic patterns in tumor characteristics and sociodemographic factors. Our finding that White women and Japanese women tend to be diagnosed at an earlier stage than other groups has been documented in earlier studies in Hawaii (43, 44). The poorer stage distribution in Black women, Hispanic women, and American Indian women has also been noted by others (1, 20, 45–57).

White patients and Japanese patients in our study were more likely than other groups to have well-differentiated breast tumors and to be positive for estrogen receptor or progesterone receptor. Ethnic differences in hormone receptor status have been documented in several studies (1, 2, 5, 8, 45, 49, 58–62). Many of these were hospital-based studies or included only breast cancer patients in clinical trials. Few adjusted for potential confounding by sociodemographic factors (1, 2). Chen et al. (1) noted that a Black/White difference in estrogen receptor status persisted among patients in three urban Surveillance, Epidemiology, and End Results registries after adjustment for socioeconomic position, body mass index, alcohol and tobacco use, reproductive experience, health care access, and usual source of care. Although we found ethnic variation in hormone receptor status and tumor grade in our study, the importance of these variables in explaining ethnic patterns of tumor stage and size, after adjustment for all other study variables, was limited primarily to the diagnosis of distant versus localized tumors.

In our study, sociodemographic factors accounted for 50–80 percent reductions in the odds ratios for distant stage and larger size breast tumors among Black patients and Hispanic patients. Associations between sociodemographic factors and the severity of breast cancer have been reported by others (3, 5, 20, 46, 50, 52, 55, 57, 63). Marital status, a strong predictor for tumor stage and size in our study, was linked to the extent of disease in a study of several cancer types in New Mexico (64). It has been suggested that married persons tend to demonstrate better health behaviors, including less delay in seeking medical care after the occurrence of symptoms, than unmarried persons do. Married persons also tend to have higher socioeconomic status and greater social support (64). Several investigators have emphasized the impact of sociodemographic factors on access to physician care or screening services (65–67). Mammography use has been found to be positively associated with income, education, having health insurance coverage, having a usual source of care, and urban residence (68–75). A number of surveys indicate that the use of mammography in the United States has risen over time (72, 74, 76), though the majority of breast cancers are still first discovered by the patient either by breast self-examination or as an incidental finding (77, 78). Despite the general increase over time in the use of mammography for early detection, surveys indicate that sociodemographic differentials persist, with women in lower income and education groups having lower screening rates (68, 71, 72, 76, 79).

A tumor size of ≥1 cm served as an indirect indicator of delayed detection in our study. Tumors of <1 cm are found primarily by screening mammography, whereas larger tumors are often detected by other methods such as symptoms, clinical breast examination, or breast self-examination (80–82). Odds ratios for larger tumors remained elevated among Black women, Hispanic women, Filipino women, and Korean women in our analysis after adjustment for all other study variables. Recent analyses of breast tumor size and stage in Asian-American women and Hispanic women in a selected subset of Surveillance, Epidemiology, and End Results Program registries have suggested that larger tumor size at diagnosis is associated with birthplace outside the United States (83, 84). Birthplace information was missing, however, on a large percentage of the cases in these studies. Furthermore, birthplace information for cancer registry cases is frequently obtained only from a death certificate, thereby resulting in a study population that is overrepresented by deceased cases. Survey data on health behaviors among Chinese women, Filipino women, Korean women, and Vietnamese women living in California, however, have indicated that these ethnic groups are less likely to report ever having had a mammogram than are women in the general population (85–90). Hispanic women have also been reported to be less likely to have undergone breast cancer

TABLE 1. Distribution of selected characteristics by percentage among 106,497 US female breast cancer patients diagnosed during 1992–1996

Characteristic	White (*n* = 84,355)	Black (*n* = 9,025)	Hispanic (*n* = 7,068)	Japanese (*n* = 1,868)	Filipino (*n* = 1,579)	Chinese (*n* = 1,385)	Hawaiian (*n* = 508)	Korean (*n* = 301)	Vietnamese (*n* = 272)	American Indian (*n* = 136)
Age at diagnosis (years)										
<50	21.0*	33.5	36.5	21.1	38.9	38.2	28.3	48.5	51.5	31.6
50–64	29.5	31.6	32.1	33.0	37.2	27.9	39.6	36.5	34.5	43.4
≥65	49.5	34.9	31.3	45.9	23.9	33.9	32.1	15.0	14.0	25.0
Stage of disease										
Localized	66.7	55.6	58.5	72.6	63.7	64.8	62.5	66.2	57.8	54.8
Regional	27.9	35.0	34.6	23.3	31.3	29.9	30.5	30.0	38.1	37.0
Distant	5.4	9.4	6.9	4.1	5.1	5.3	7.0	3.8	4.1	8.2
Unknown	2.9†	5.1†	3.2†	1.4†	2.4†	2.4†	1.8†	4.6†	1.5†	0.7†
Tumor size (cm)										
<1.0	19.0	11.2	12.6	22.9	13.0	15.3	14.1	11.4	13.9	17.2
1.0–1.9	38.5	30.5	29.8	41.4	31.1	36.6	38.9	37.2	25.9	32.8
≥2.0	42.5	58.3	57.7	35.8	55.9	48.1	47.0	51.4	60.2	50.0
Unknown	8.9†	11.8†	8.6†	7.3†	7.1†	8.5†	7.5†	7.0†	4.8†	5.9†
Tumor grade										
1	16.4	10.5	11.6	17.2	11.9	11.8	10.8	9.8	11.1	6.6
2	42.9	32.2	37.8	43.8	42.8	42.3	38.8	36.6	35.6	47.2
3 or 4	40.7	57.3	50.6	39.0	45.3	45.9	50.4	53.6	53.3	46.2
Unknown	25.1†	29.8†	24.9†	22.9†	23.9†	21.8†	25.0†	21.9†	17.3†	22.1†
Estrogen receptor status										
Positive	76.4	58.9	68.0	76.6	72.4	71.0	76.8	65.0	67.2	66.1
Negative	22.6	39.8	31.1	22.9	27.3	27.9	21.7	34.2	31.8	32.1
Borderline	1.0	1.3	0.9	0.5	0.3	1.1	1.5	0.8	1.0	1.8
Unknown	22.1†	30.0†	30.1†	16.6†	21.4†	22.0†	11.0†	22.3†	28.3†	17.6†
Progesterone receptor status										
Positive	66.5	52.2	60.3	68.2	65.3	65.2	73.0	57.6	61.5	52.2
Negative	32.2	46.5	38.7	31.0	33.7	33.8	26.1	41.5	38.5	46.0
Borderline	1.3	1.3	1.0	0.8	1.0	1.0	0.9	0.9	0.0	1.8
Unknown	24.7†	32.0†	32.0†	17.9†	23.4†	23.9†	12.4†	23.3†	29.4†	18.4†
Surveillance, Epidemiology, and End Results area										
Atlanta, GA	5.6	18.0	0.7	0.2	0.3	0.4	0.0	1.0	0.7	0.0
Connecticut	13.5	6.9	4.5	0.5	0.1	0.6	0.0	1.0	1.8	0.0
Detroit, MI	12.3	29.1	0.9	0.3	1.2	1.4	0.2	1.0	1.1	0.0
Hawaii	1.1	0.3	0.3	54.8	18.9	14.8	93.1	20.3	1.5	0.0
Iowa	11.7	1.2	0.7	0.0	0.3	0.3	0.0	0.7	0.4	0.0
Los Angeles, CA	17.8	27.8	52.0	23.2	38.1	28.9	3.1	45.5	44.5	0.0
New Mexico	3.5	0.5	15.3	0.3	0.2	0.5	0.2	1.6	0.4	100.0
San Jose and Monterey, CA	5.6	1.3	9.6	4.9	10.3	10.0	0.8	7.6	22.8	0.0
San Francisco Bay Area, CA	11.3	12.0	12.8	9.3	24.4	38.8	1.6	10.0	16.2	0.0
Seattle, WA	13.1	2.8	1.7	5.8	6.1	4.0	0.6	9.3	9.5	0.0
Utah	4.5	0.1	1.5	0.7	0.1	0.3	0.4	2.0	1.1	0.0
Country of birth										
United States	89.6	96.6	47.9	78.8	10.7	26.8	100.0	7.7	2.7	100.0
Foreign	10.4	3.4	52.1	21.2	89.3	73.2	0.0	92.3	97.3	0.0
Unknown	52.3†	50.2†	35.1†	22.9†	23.0†	34.0†	7.9†	22.3†	18.8†	21.3†

Marital status										
Married	56.6	37.7	54.5	62.5	63.0	69.4	56.0	69.8	66.9	64.1
Not married	43.4	62.3	45.5	37.5	37.0	30.6	44.0	30.2	33.1	35.9
Unknown	2.7†	4.6†	2.5†	1.4†	2.0†	2.3†	0.6†	2.0†	1.1†	3.7†
Urban census tract										
Urban	73.7	94.8	87.2	94.1	93.5	96.3	74.8	94.8	98.1	7.8
Nonurban	26.3	5.2	12.8	5.9	6.5	3.7	25.2	5.2	1.9	92.2
Unknown	3.8†	3.0†	4.1†	6.0†	6.9†	3.4†	20.3†	4.3†	4.4†	5.9†
Without high school diploma in census tract (%)										
0–8	23.6	4.7	8.1	15.4	8.6	23.1	6.4	16.3	9.2	0.8
9–28	64.3	37.1	40.8	65.8	53.8	52.2	60.0	62.2	48.5	32.8
≥29	12.1	58.2	51.1	18.8	37.6	24.7	33.6	21.5	42.3	66.4
Unknown	3.8†	3.0†	4.1†	6.0†	6.9†	3.4†	20.3†	4.3†	4.4†	5.9†
Working class in census tract (%)										
0–50	22.0	5.9	9.1	19.0	7.4	25.0	6.4	18.1	8.9	0.0
51–73	63.5	43.6	49.5	67.5	58.6	58.0	72.6	63.9	56.5	64.8
≥74	14.5	50.5	41.4	13.5	34.0	17.0	21.0	18.0	34.6	35.2
Unknown	3.8†	3.0†	4.1†	6.0†	6.9†	3.5†	20.3†	4.3†	4.4†	5.9†
Median family income ($) in census tract										
<25,000	5.3	39.1	22.1	3.0	9.1	8.5	5.7	12.2	16.5	75.8
25,000–49,000	56.8	50.3	60.0	52.3	61.6	47.1	65.9	53.1	58.1	24.2
≥50,000	37.9	10.6	17.9	44.7	29.3	44.4	28.4	34.7	25.4	0.0
Unknown	3.8†	3.0†	4.1†	6.0†	6.9†	3.4†	20.3†	4.3†	4.4†	5.9†
Families with female head of household, no husband, one or more children <18 years of age, and income below poverty level in census tract										
0	28.4	6.0	12.3	35.2	19.5	30.8	22.0	25.0	16.2	1.6
1–4	56.3	24.8	45.7	54.0	55.9	56.3	55.3	61.1	46.5	13.3
≥5	15.4	69.2	42.0	10.8	24.6	12.9	22.7	13.9	37.3	85.1
Unknown	3.8†	3.0†	4.1†	6.0†	6.9†	3.5†	20.3†	4.3†	4.4†	5.9†
Own home in census tract (%)										
0–45	16.7	40.6	37.0	26.7	31.3	33.7	20.7	42.4	40.8	3.9
46–85	62.1	53.0	54.7	59.6	58.7	49.0	73.1	45.5	51.9	65.6
≥86	21.2	6.4	8.3	13.7	10.0	17.3	6.2	12.1	7.3	30.5
Unknown	3.8†	3.0†	4.1†	6.0†	6.9†	3.5†	20.3†	4.3†	4.4†	5.9†
Don't own car in census tract (%)										
0–2	28.2	6.4	13.3	24.0	22.2	24.2	19.5	26.7	18.1	6.2
3–12	58.8	29.1	55.5	52.6	50.1	43.2	57.3	42.4	51.5	31.3
≥13	13.0	64.5	31.2	23.4	27.7	32.6	23.2	30.9	30.4	62.5
Unknown	3.8†	3.0†	4.1†	6.0†	6.9†	3.5†	20.3†	4.3†	4.4†	5.9†
Foreign born in census tract (%)										
0–3	24.6	37.8	8.0	1.8	1.4	0.6	10.1	3.8	2.3	85.9
4–21	61.2	39.8	37.1	63.6	33.5	41.5	66.2	39.6	31.5	14.1
≥22	14.2	22.4	54.9	34.6	65.1	57.9	23.7	56.6	66.2	0.0
Unknown	3.8†	3.0†	4.1†	6.0†	6.9†	3.4†	20.3†	4.3†	4.4†	5.9†

* Percentage of known values.
† Percentage of known and unknown values.

TABLE 2. Adjusted odds ratios and 95% confidence intervals for distant stage breast cancer versus localized stage among specific US racial/ethnic groups, 1992–1996

			Adjustment variables by model							
	No.	% distant	Model 1 (age)		Model 2 (age, registry, urban area)		Model 3 (age, registry, urban area, SDF*)		Model 4 (age, registry, urban area, SDF, tumor grade, ER/PR*)	
			OR*	95% CI*	OR	95% CI	OR	95% CI	OR	95% CI
White†	56,952	7.4	1.0		1.0		1.0		1.0	
Black	5,413	14.2	2.1	1.9, 2.2	2.0	1.8, 2.2	1.5	1.3, 1.6	1.3	1.1, 1.4
Hispanic	4,302	10.6	1.5	1.3, 1.7	1.5	1.3, 1.6	1.1	1.0, 1.3	1.0	0.9, 1.2
Japanese	1,329	5.2	0.7	0.5, 0.9	0.7	0.6, 1.0	0.7	0.5, 0.9	0.7	0.6, 1.0
Filipino	989	7.1	1.0	0.7, 1.2	1.0	0.8, 1.3	0.9	0.7, 1.1	0.8	0.7, 1.1
Chinese	911	7.8	1.1	0.8, 1.3	1.2	0.9, 1.5	1.1	0.9, 1.4	1.0	0.8, 1.3
Hawaiian	288	9.7	1.3	0.9, 2.0	1.5	1.0, 2.3	1.3	0.8, 2.0	1.3	0.8, 2.1
Korean	193	5.2	0.7	0.3, 1.2	0.7	0.3, 1.3	0.6	0.3, 1.2	0.6	0.3, 1.1
Vietnamese	161	6.2	0.8	0.4, 1.5	0.9	0.4, 1.6	0.7	0.4, 1.3	0.7	0.4, 1.3
American Indian	79	13.9	2.0	1.0, 3.7	1.8	0.9, 3.3	1.3	0.6, 2.4	1.3	0.7, 2.6

* SDF, sociodemographic factors including marital status of the patient at the time of diagnosis and the following attributes of the census tract where the patient resided at the time of her diagnosis: % without a high school diploma; % working class; % families headed by women with no husband at home, with one or more children, and who are living below the poverty level; median family income; % home ownership; and % car ownership; ER/PR, estrogen and progesterone receptor status; OR, odds ratio; CI, confidence interval.

† Reference category.

TABLE 3. Adjusted odds ratios and 95% confidence intervals for regional stage breast cancer versus localized stage among specific US racial/ethnic groups, 1992–1996

			Adjustment variables by model							
	No.	% regional	Model 1 (age)		Model 2 (age, registry, urban area)		Model 3 (age, registry, urban area, SDF*)		Model 4 (age, registry, urban area, SDF, tumor grade, ER/PR*)	
			OR*	95% CI*	OR	95% CI	OR	95% CI	OR	95% CI
White†	74,754	29.4	1.0		1.0		1.0		1.0	
Black	7,557	38.5	1.4	1.3, 1.4	1.3	1.3, 1.4	1.2	1.1, 1.3	1.2	1.1, 1.2
Hispanic	6,115	37.1	1.3	1.2, 1.3	1.2	1.2, 1.3	1.1	1.1, 1.2	1.1	1.1, 1.2
Japanese	1,661	24.1	0.7	0.7, 0.8	0.8	0.7, 0.9	0.8	0.7, 0.9	0.8	0.7, 0.9
Filipino	1,370	32.9	1.0	0.9, 1.2	1.1	0.9, 1.2	1.0	0.9, 1.1	1.0	0.9, 1.1
Chinese	1,236	32.0	1.0	0.9, 1.1	1.0	0.9, 1.2	1.0	0.9, 1.2	1.0	0.9, 1.1
Hawaiian	372	30.1	1.0	0.8, 1.2	1.1	0.9, 1.4	1.1	0.8, 1.4	1.0	0.8, 1.3
Korean	267	31.5	0.9	0.7, 1.2	0.9	0.7, 1.2	0.9	0.7, 1.2	0.9	0.7, 1.1
Vietnamese	247	38.9	1.2	1.0, 1.6	1.2	1.0, 1.6	1.2	0.9, 1.5	1.1	0.9, 1.5
American Indian	116	41.4	1.5	1.0, 2.2	1.4	1.0, 2.0	1.3	0.9, 1.8	1.3	0.9, 1.9

* SDF, sociodemographic factors including marital status of the patient at the time of diagnosis and the following attributes of the census tract where the patient resided at the time of her diagnosis: % without a high school diploma; % working class; % families headed by women with no husband at home, with one or more children, and who are living below the poverty level; median family income; % home ownership; and % car ownership; ER/PR, estrogen and progesterone receptor status; OR, odds ratio; CI, confidence interval.

† Reference category.

TABLE 4. Adjusted odds ratios and 95% confidence intervals for breast cancer tumor size equal to or greater than 1 cm in diameter versus less than 1 cm among specific US racial/ethnic groups, 1992–1996

	No.	% ≥1 cm	Adjustment variables by model							
			Model 1 (age)		Model 2 (age, registry, urban area)		Model 3 (age, registry, urban area, SDF*)		Model 4 (age, registry, urban area, SDF, tumor grade, ER/PR*)	
			OR*	95% CI*	OR	95% CI	OR	95% CI	OR	95% CI
White†	74,053	81.0	1.0		1.0		1.0		1.0	
Black	7,744	88.8	1.8	1.7, 1.9	1.8	1.7, 1.9	1.5	1.3, 1.6	1.4	1.3, 1.5
Hispanic	6,215	87.4	1.6	1.4, 1.7	1.4	1.3, 1.6	1.2	1.1, 1.3	1.2	1.1, 1.3
Japanese	1,630	77.0	0.8	0.7, 0.9	0.8	0.7, 1.0	0.8	0.7, 1.0	0.8	0.7, 1.0
Filipino	1,369	87.1	1.5	1.3, 1.8	1.5	1.3, 1.8	1.4	1.2, 1.6	1.4	1.2, 1.6
Chinese	1,230	84.7	1.3	1.1, 1.5	1.3	1.1, 1.5	1.2	1.1, 1.5	1.2	1.0, 1.4
Hawaiian	379	85.0	1.3	1.0, 1.7	1.5	1.1, 2.1	1.4	1.0, 1.9	1.3	1.0, 1.8
Korean	270	88.5	1.7	1.2, 2.5	1.7	1.2, 2.5	1.6	1.1, 2.4	1.6	1.1, 2.3
Vietnamese	248	85.9	1.3	0.9, 1.9	1.3	0.9, 1.8	1.1	0.8, 1.6	1.1	0.7, 1.6
American Indian	121	83.5	1.1	0.7, 1.9	1.1	0.7, 1.8	0.9	0.5, 1.5	0.9	0.5, 1.5

* SDF, sociodemographic factors including marital status of the patient at the time of diagnosis and the following attributes of the census tract where the patient resided at the time of her diagnosis: % without a high school diploma; % working class; % families headed by women with no husband at home, with one or more children, and who are living below the poverty level; median family income; % home ownership; and % car ownership; ER/PR, estrogen and progesterone receptor status; OR, odds ratio; CI, confidence interval.

† Reference category.

screening than non-Hispanic White women (91, 92). This suggests the possibility that lower utilization of mammography in these ethnic groups may be leading to the diagnosis of more advanced tumors. Factors associated with lower screening rates among women in these studies included the lack of a physician recommendation for a mammogram, concern over cost, belief that a mammogram is needed only in the presence of symptoms, perceived inconvenience or difficulties in getting to the mammography facility, and embarrassment.

Odds ratios for distant and regional stage disease among Black women in our study relative to White women remained slightly elevated after adjusting for sociodemographic variables and tumor biology. Several other studies have found that sociodemographic effects alone do not account for all of the ethnic differences in tumor stage at diagnosis (47, 52, 63, 93–95). Even in situations where universal access to medical care is provided, ethnic disparities in breast cancer diagnosis or outcome persist (73, 96, 97). Cultural factors such as beliefs, attitudes, and knowledge about cancer have been shown to vary by ethnicity and have been found to influence cancer screening and prevention behaviors (57, 90, 98–104). Results from a recent case-control study of breast cancer patients diagnosed in an eastern North Carolina hospital indicated that psychosocial and cultural beliefs in conjunction with socioeconomic factors were sufficient to explain the difference in stage at diagnosis between Black women and White women (57). The investigators concluded that cultural beliefs may have led to delayed presentation once a woman had developed a palpable breast abnormality. An earlier study of women in the same North Carolina communities found that personal knowledge and beliefs had little influence, however, on a woman's use of screening mammography (105). The most important factor was whether mammography was recommended to the patient by a physician. Another study of breast cancer patients identified within a health maintenance organization setting in North Carolina also found that patient delay before reporting breast cancer symptoms to a physician was an important factor in explaining tumor stage at the time of diagnosis (106).

Our finding that Japanese patients tended to be diagnosed at an earlier stage and smaller tumor size than other groups has been reported by others (83, 107–110). It has been suggested that differences in the histopathologic features of breast cancers in Japanese women and White women may indicate underlying biologic differences in the tumors between these two groups (110, 111). Adjustment for tumor grade and hormone receptor status, in addition to sociodemographic factors, did not alter the reduced odds ratios among Japanese women for any of our study outcomes.

Evidence for a role of tumor grade or hormone receptor status in explaining ethnic differences in breast cancer stage and size at diagnosis was not compelling in our study. After adding these variables to the regression models, we found that odds ratios for Black women declined somewhat for distant stage disease but did not markedly change in any of the ethnic groups for regional stage disease or larger tumor size. These findings must be interpreted with caution because of the large percentage (about 20 percent) of study cases with missing information on either hormone receptor status or tumor grade.

Only limited risk factor information was available from cancer registry records on our study subjects. Individual information on factors such as body mass, alcohol and tobacco use, reproductive history, medical insurance status, usual source of health care, and screening behavior would have been helpful in evaluating the ethnic patterns of tumor stage and size at the time of diagnosis. Although the utility and advantages of using neighborhood-level sociodemographic data have been shown in a variety of studies assessing the impact of socioeconomic position on health outcomes (24, 27, 32, 37, 38, 112, 113), the addition of individual-level sociodemographic information would have allowed a multilevel assessment of the importance of these factors in our study population. Using neighborhood-level sociodemographic data may also lead to residual confounding by socioeconomic position because the aggregated measures lack distributional information (114–116). This residual confounding and/or the influence of other important unmeasured factors could explain the persistence of slightly elevated odds ratios for some ethnic groups in this study. Nevertheless, several investigators support the increased use of neighborhood-based measures of socioeconomic position in public health research and surveillance because they capture aspects of a person's living conditions that may be missing from individual measures (4, 32). Neighborhood-level measures may also provide a more stable estimate of the economic situation of persons than do some of the more volatile individual measures such as personal income.

Our results suggest that the sociodemographic factors measured in this study can account for a large portion of observed ethnic differences in breast cancer stage and tumor size at the time of diagnosis. It would be useful to confirm these findings in additional studies that include patient-level sociodemographic data as well as area-based measures. Since a sociodemographic disparity in mammography screening levels has been documented in several population surveys, methods for increasing compliance with recommended guidelines should be identified and implemented. Additional studies could focus on the relations between sociodemographic factors and the quality of mammography, whether mammography is received at regular intervals, and whether appropriate follow-up and treatment are given to identified cases. Further study is also needed to determine whether differential exposure to carcinogens, genetic susceptibility, or some other factors may lead to more aggressive forms of breast cancer.

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REFERENCES

1. Chen VW, Correa P, Kurman RJ, et al. Histological characteristics of breast carcinoma in blacks and whites. Cancer Epidemiol Biomarkers Prev 1994;3:127–35.
2. Gordon N. Association of education and income with estrogen receptor status in primary breast cancer. Am J Epidemiol 1995;142:796–803.
3. Weiss SE, Tartter PI, Ahmed S, et al. Ethnic differences in risk and prognostic factors for breast cancer. Cancer 1995;76: 268–74.
4. Krieger N, Van Den Eeden SK, Zava D, et al. Race/ethnicity, social class, and prevalence of breast cancer prognostic biomarkers: a study of white, black, and Asian women in the San Francisco bay area. Ethn Dis 1997;7:137–49.
5. Elmore JG, Moceri VM, Carter D, et al. Breast carcinoma tumor characteristics in black and white women. Cancer 1998;83:2509–15.
6. Donegan WL. Tumor-related prognostic factors for breast cancer. CA Cancer J Clin 1997;47:28–51.
7. Osborne CK. Steroid hormone receptors in breast cancer management. Breast Cancer Res Treat 1998;51:227–38.
8. Mohla S, Sampson CC, Khan T, et al. Estrogen and progesterone receptors in breast cancer in black Americans: correlation of receptor data with tumor differentiation. Cancer 1982;50:552–9.
9. Pegararo RJ, Karnan V, Nirmul D, et al. Estrogen and progesterone receptors in breast cancer among women of different racial groups. Cancer Res 1986;46:2117–20.
10. Dhingra K, Hortobagyi GN. Critical evaluation of prognostic factors. Semin Oncol 1996;23:436–45.
11. Henson DE, Ries L, Freedman LS, et al. Relationship among outcome, stage of disease, and histologic grade for 22,616 cases of breast cancer: the basis for a prognostic index. Cancer 1991;68:2142–9.
12. Fisher ER, Anderson S, Redmond C, et al. Pathologic findings from the National Surgical Adjuvant Breast Project protocol B-06: 10-year pathologic and clinical prognostic discriminants. Cancer 1993;71:2507–14.
13. Garne JP, Aspegren K, Linell F, et al. Primary prognostic factors in invasive breast cancer with special reference to ductal carcinoma and histologic malignancy grade. Cancer 1994; 73:1438–48.
14. US Bureau of the Census. Census of population and housing, 1990: summary tape file 3A on CD-ROM. Washington, DC: Bureau of the Census, 1992.
15. Wright EO, Costello C, Hachen D, et al. The American class structure. Am Sociol Rev 1982;47:709–26.
16. Berkman LF, Macintyre S. The measurement of social class in health studies: old measures and new formulations. In: Kogevinas M, Pearce N, Susser M, et al, eds. Social inequalities and cancer. Lyon, France: International Agency for Research on Cancer, 1997. (IARC scientific publication no. 138).
17. Krieger N, Williams DR, Moss NE. Measuring social class in U.S. public health research: concepts, methodologies and guidelines. Annu Rev Public Health 1997;18:341–78.
18. Faia MA. Selection by certification: a neglected variable in stratification research. Am J Sociol 1981;86:1093–111.
19. Devesa SS, Diamond EL. Socioeconomic and racial differences in lung cancer incidence. Am J Epidemiol 1983;118: 818–31.

20. Bassett M, Krieger N. Social class and black-white differences in breast cancer survival. Am J Public Health 1986;76: 1400–3.
21. Liberatos P, Link BG, Kelsey JL. The measurement of social class in epidemiology. Epidemiol Rev 1988;10:87–121.
22. Feldman JJ, Makuc DM, Kleinman JC, et al. National trends in educational differences in mortality. Am J Epidemiol 1989;129:919–33.
23. Krieger N. Social class and the black/white crossover in age-specific incidence of breast cancer: a study linking census-derived data to population-based registry records. Am J Epidemiol 1990;131:804–14.
24. Massey DS, Eggers ML. The ecology of inequality: minorities and the concentration of poverty, 1970–1980. Am J Sociol 1990;95:1153–88.
25. Krieger N. Women and social class: a methodological study comparing individual, household, and census measures as predictors of black/white differences in reproductive history. J Epidemiol Community Health 1991;45:35–42.
26. Reis P. Educational differences in health status and health care. Hyattsville, MD: National Center for Health Statistics, 1991. (DHHS publication no. (PHS) 91–1507).
27. Krieger N. Overcoming the absence of socioeconomic data in medical records: validation and application of a census-based methodology. Am J Public Health 1992;82:703–10.
28. Petridou E, Kosmidis H, Haidas S, et al. Survival from childhood leukemia depending on socioeconomic status in Athens. Oncology 1994;51:391–5.
29. Ellen JM, Kohn RP, Bolan GA, et al. Socioeconomic differences in sexually transmitted disease rates among black and white adolescents, San Francisco, 1990 to 1992. Am J Public Health 1995;85:1546–8.
30. Filakti H, Fox J. Differences in mortality by housing tenure and by car access from the POCS longitudinal study. Popul Trends 1995;81:27–30.
31. Greenwald HP, Polissar NY, Dayal HH. Race, soeioeconomic status and survival in three female cancers. Ethn Health 1996;1:65–75.
32. Kaplan GA. People and places: contrasting perspectives on the association between social class and health. Int J Health Serv 1996;26:507–19.
33. Smith GD, Neaton JD, Wentworth D, et al. Socioeconomic differentials in mortality among men screened for the Multiple Risk Factor Intervention Trial. I. White men. Am J Public Health 1996;86:486–96.
34. Smith GD, Wentworth D, Neaton JD, et al. Socioeconomic differentials in mortality among men screened for the Multiple Risk Factor Intervention Trial. II. Black men. Am J Public Health 1996;86:497–504.
35. Anderson RT, Sorlie P, Backlund E, et al. Mortality effects of community socioeconomic status. Epidemiology 1997;8: 42–7.
36. Heck KE, Wabener DK, Schatzkin A, et al. Socioeconomic status and breast cancer mortality, 1989 through 1993: an analysis of education data from death certificates. Am J Public Health 1997;87:1218–22.
37. Hofer TP, Wolfe RA, Tedeschi PJ, et al. Use of community versus individual socioeconomic data in predicting variation in hospital use. Health Serv Res 1998;33:243–59.
38. Robert SA. Community-level socioeconomic status effects on adult health. J Health Soc Behav 1998;39:18–37.
39. Graubard BI, Korn EL. Regression analysis with clustered data. Stat Med 1994;13:509–22.
40. Allison PD. Logistic regression using the SAS7 system: theory and application. Cary, NC: SAS Institute, Inc, 1999.
41. Binder DA. On the variances of asymptotically normal estimators from complex surveys. Int Stat Rev 1983;51:279–92.
42. Shah BV, Barnwell BG, Bieler GS. SUDAAN user's manual, release 7.5. Research Triangle Park, NC: Research Triangle Institute, 1997.
43. Le Marchand L, Kolonel LN, Nomura AMY. Relationship of ethnicity and other prognostic factors to breast cancer survival patterns in Hawaii. J Natl Cancer Inst 1984;73:1259–65.
44. Meng L, Maskarinec G, Wilkens L. Ethnic differences and factors related to breast cancer survival in Hawaii. Int J Epidemiol 1997;26:1151–8.
45. Ownby HE, Frederick J, Russo J, et al. Racial differences in breast cancer patients. J Natl Cancer Inst 1985;75:55–60.
46. Polednak AP. Breast cancer in black and white women in New York State: case distribution and incidence rates by clinical stage at diagnosis. Cancer 1986;58:807–15.
47. Bain RP, Greenberg RS, Whitaker JP. Racial differences in survival of women with breast cancer. J Chronic Dis 1986; 39:631–42.
48. Samet JM, Key CR, Hunt WC, et al. Survival of American Indian and Hispanic cancer patients in New Mexico and Arizona, 1969–1982. J Natl Cancer Inst 1987;79:457–63.
49. Stanford JL, Greenberg RS. Breast cancer incidence in young women by estrogen receptor status and race. Am J Public Health 1989;79:71–3.
50. Farley TA, Flannery JT. Late-stage diagnosis of breast cancer in women of lower socioeconomic status: public health implications. Am J Public Health 1989;79:1508–12.
51. Ragland KE, Selvin S, Merrill DW. Black-white differences in stage-specific cancer survival: analysis of seven selected sites. Am J Epidemiol 1991;33:672–82.
52. Wells BL, Horm JW. Stage at diagnosis in breast cancer: race and socioeconomic factors. Am J Public Health 1992;82: 1383–5.
53. Eley JW, Hill HA, Chen VW, et al. Racial differences in survival from breast cancer. Results of the National Cancer Institute Black/White Cancer Survival Study. JAMA 1994; 272:947–54.
54. Simon MS, Severson RK. Racial differences in survival of female breast cancer in the Detroit metropolitan area. Cancer 1996;77:308–14.
55. Bentley JR, Delfino RJ, Taylor TH, et al. Differences in breast cancer stage at diagnosis between non-Hispanic white and Hispanic populations, San Diego County 1988–1993. Breast Cancer Res Treat 1998;50:1–9.
56. Jones BA, Kasl SV, Curnen MGM, et al. Severe obesity as an explanatory factor for the black/white difference in stage at diagnosis of breast cancer. Am J Epidemiol 1998;146:394–404.
57. Lannin DR, Mathews HF, Mitchell J, et al. Influence of socioeconomic and cultural factors on racial differences in late-stage presentation of breast cancer. JAMA 1998;279: 1801–7.
58. Pegararo RJ, Karnan V, Nirmul D, et al. Estrogen and progesterone receptors in breast cancer among women of different racial groups. Cancer Res 1986;46:2117–20.
59. Beverly LN, Flanders WD, Go RCP, et al. A comparison of estrogen and progesterone receptors in black and white breast cancer patients. Am J Public Health 1987;77:351–3.
60. Stanford JL, Szklo M, Boring CC, et al. A case-control study of breast cancer stratified by estrogen receptor status. Am J Epidemiol 1987;125:184–94.
61. Hulka BS, Liu ET, Lininger RA. Steroid hormones and risk of breast cancer. Cancer 1994;74:1111–24.
62. Elledge RM, Clark GM, Chanmess GC, et al. Tumor biologic factors and breast cancer prognosis among white, Hispanic, and black women in the United States. J Natl Cancer Inst 1994;86:705–12.
63. Gapstur SM, Dupuis J, Gann P, et al. Hormone receptor status of breast tumors in black, Hispanic, and non-Hispanic white women: an analysis of 13,239 cases. Cancer 1996;77: 1465–71.
64. Mandelblatt J, Andrews H, Kerner J, et al. Determinants of late stage diagnosis of breast and cervical cancer: the impact of age, race, social class, and hospital type. Am J Public Health 1991;81:646–9.
65. Goodwin JS, Hunt WC, Key CR, et al. The effect of marital status on stage, treatment, and survival of cancer patients. JAMA 1987;258:3125–30.
66. Gregorio D, Cummings M, Michalek A. Delay, stage of disease and survival among White and Black women with breast

cancer. Am J Public Health 1983;73:590–3.
67. Harper AP. Mammography utilization in the poor and medically underserved. Cancer 1993;72:1478–82.
68. Hoffman-Goetz L, Breen NL, Meissner H. The impact of social class on the use of cancer screening within three racial/ethnic groups in the United States. Ethn Dis 1998;8:43–51.
69. Rakowski W, Rimer BK, Bryant SA. Integrating behavior and intention regarding mammography by respondents in the 1990 National Health Interview Survey of Health Promotion and Disease Prevention. Public Health Rep 1993;108:605–24.
70. Horton JA, Romans MC, Cruess DF. Mammography attitudes and usage study, 1992. Womens Health Issues 1992;2:180–6.
71. Horton JA, Cruess DF, Romans MC. Compliance with mammography screening guidelines: 1995 mammography attitudes and usage study report. Womens Health Issues 1996;6:239–45.
72. Breen N, Kessler L. Changes in the use of screening mammography: evidence from the 1987 and 1990 National Health Interview Surveys. Am J Public Health 1994;84:62–7.
73. Katz SJ, Hofer TP. Socioeconomic disparities in preventive care persist despite universal coverage: breast and cervical cancer screening in Ontario and the United States. JAMA 1994;272:530–4.
74. Anderson LM, May DS. Has the use of cervical, breast, and colorectal cancer screening increased in the United States? Am J Public Health 1995;85:840–2.
75. Coughlin SS, Uhler RJ, Blackman DK. Breast and cervical cancer screening practices among American Indian and Alaska Native women in the United States, 1992–1997. Prev Med 1999;29:287–95.
76. Makuc DM, Breen N, Freid V. Low income, race, and the use of mammography. Health Serv Res 1999;34:229–39.
77. Norton L, Crown JP. Malignancies of epithelial tissue: breast cancer. In: Kelley WN, ed. Textbook of internal medicine. 2nd ed. Philadelphia, PA: JB Lippincott Company, 1992:1069–72.
78. McPherson CP, Swenson KK, Jolitz G, et al. Survival of women ages 40–49 years with breast carcinoma according to method of detection. Cancer 1997;79:1923–32.
79. Blackman DK, Bennett EM, Miller DS. Trends in self-reported use of mammograms (1989–1997) and Papanicolaou tests (1991–1997)—Behavioral Risk Factor Surveillance System. Mor Mortal Wkly Rep CDC Surveill Summ 1999;48:1–22.
80. Fletcher SW, O'Malley MS, Bunce LA. Physicians' abilities to detect lumps in silicone breast models. JAMA 1985;253:2224–8.
81. Reintgen D, Berman C, Cox C, et al. The anatomy of missed breast cancers. Surg Oncol 1993;2:65–75.
82. Helzlsouer KJ. Early detection and prevention of breast cancer. In: Greenwald P, Kramer BS, Weed DL, eds. Cancer prevention and control. New York, NY: Marcel Dekker, Inc, 1994:509–33.
83. Hedeen AN, White E, Taylor V. Ethnicity and birthplace in relation to tumor size and stage in Asian American women with breast cancer. Am J Public Health 1999;89:1248–52.
84. Hedeen AN, White E. Breast cancer size and stage in Hispanic American women, by birthplace: 1992–1995. Am J Public Health 2001;91:122–5.
85. Behavioral Risk Factor Survey of Chinese—California, 1989. MMWR Morb Mortal Wkly Rep 1992;41:266–70.
86. Behavioral Risk Factor Survey of Vietnamese—California, 1991. MMWR Morb Mortal Wkly Rep 1992;41:69–72.
87. Hiatt RA, Pasick RJ. Unresolved problems in early breast cancer detection: focus on the underserved. Breast Cancer Res Treat 1996;40:37–51.
88. Hiatt RA, Pasick RJ, Pérez-Stable EJ, et al. Pathways to early cancer detection in the multiethnic population of the San Francisco Bay Area. Health Educ Q 1996;23(suppl):S10–27.
89. Behavioral Risk Factor Survey of Korean Americans—Alameda County, California, 1994. MMWR Morb Mortal Wkly Rep 1997;46:774–7.
90. Maxwell AE, Bastani R, Warda US. Breast cancer screening and related attitudes among Filipino-American women. Cancer Epidemiol Biomarkers Prev 1997;6:719–26.
91. Vernon SW, Vogel VG, Halabi S, et al. Breast cancer screening behaviors and attitudes in three racial/ethnic groups. Cancer 1992;69:165–74.
92. Trends in self-reported use of mammograms (1989–1997) and Papanicolaou tests (1991–1997)—Behavioral Risk Factor Surveillance System. Mor Mortal Wkly Rep CDC Surveill Summ 1999;48:1–22.
93. Vernon SW, Tillery BC, Neale AV, et al. Ethnicity, survival, and delay in seeking treatment for symptoms of breast cancer. Cancer 1985;55:1563–71.
94. Richardson JL, Langholz B, Bernstein L, et al. Stage and delay in breast cancer diagnosis by race, socioeconomic status, age, and year. Br J Cancer 1992;65:922–6.
95. Hunter CP, Redmond CK, Chen VW, et al. Breast cancer: factors associated with stage at diagnosis in black and white women. J Natl Cancer Inst 1993;85:1129–37.
96. Trock B, Rimer BK, King E, et al. Impact of an HMO-based intervention to increase mammography utilization. Cancer Epidemiol Biomarkers Prev 1993;2:151–6.
97. Wojcik BE, Spinks MK, Optenberg SA. Breast cancinoma survival analysis for African American and white women in an equal-acess health care system. Cancer 1998;82:1310–18.
98. Michielutte R, Diseker RA. Racial differences in knowledge of cancer. Soc Sci Med 1982;16:245–53.
99. Jepson C, Kessler LG, Portnoy B, et al. Black-white differences in cancer prevention knowledge and behavior. Am J Public Health 1991;81:501–4.
100. Loehrer PJ, Greger HA, Weinberger M, et al. Knowledge and beliefs about cancer in a socioeconomically disadvantaged population. Cancer 1991;68:1665–71.
101. Perez-Stable EJ, Sabogal F, Otero-Sabogal R, et al. Misconceptions about cancer among Latinos and Anglos. JAMA 1992;268:3219–23.
102. Harper AP. Mammography utilization in the poor and medically underserved. Cancer 1993;72:1478–82.
103. Pachter LM. Culture and clinical care: folk illness beliefs and behaviors and their implications for health care delivery. JAMA 1994;271:690–4.
104. Lobell M, Bay RC, Rhoads KVL, et al. Barriers to cancer screening in Mexican-American women. Mayo Clin Proc 1998;73:301–8.
105. O'Malley MS, Earp JA, Harris RP. Race and mammography use in two North Carolina counties. Am J Public Health 1997;87:782–6.
106. Howard DL, Penchansky R, Brown MB. Disaggregating the effects of race on breast cancer survival. Fam Med 1998;30:228–35.
107. Ward-Hinds M, Kolonel LN, Nomura AM, et al. Stage-specific breast cancer incidence rates by age among Japanese and Caucasian women in Hawaii, 1960–1979. Br J Cancer 1982;45:118–23.
108. Le Marchand L, Kolonel LN, Nomura AMY. Relationship of ethnicity and other prognostic factors to breast cancer survival patterns in Hawaii. J Natl Cancer Inst 1984;73:1259–65.
109. Stemmermann GN, Catts A, Fukunaga F, et al. Breast cancer in women of Japanese and Caucasian ancestry in Hawaii. Cancer 1985;56:206–9.
110. Higuchi CM, Serxner SA, Nomura AMY, et al. Histopathological predictors of breast cancer death among Caucasians and Japanese in Hawaii. Cancer Epidemiol Biomarkers Prev 1993;2:201–5.
111. Stemmermann GN. The pathology of breast cancer in Japanese women compared to other ethnic groups: a review. Breast Cancer Res Treat 1991;18(suppl):S67–72.
112. Hakama M, Hakulinen T, Pukkala E, et al. Risk indicators of breast and cervical cancer on ecologic and individual levels. Am J Epidemiol 1982;116:990–1000.
113. Anderson RT, Sorlie P, Backlund E, et al. Mortality effects of

community socioeconomic status. Epidemiology 1997;8: 42–7.
114. Greenland S, Robins J. Invited commentary: ecologic studies—biases, misconceptions, and counterexamples. Am J Epidemiol 1994;139:747–60.
115. Sheppard L, Prentice RL, Rossing M. Design considerations for estimation of exposure effects on disease risk, using aggregate data studies. Stat Med 1996;15:1849–58.
116. Kaufman JS, Cooper RS, McGee DL. Socioeconomic status and health in blacks and whites: the problem of residual confounding and the resiliency of race. Epidemiology 1997;8: 621–8.